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Impact of Index Options on Emerging Market Volatility: The Case of the Malaysian Equity Market

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Abstract: This study investigates the impact of the introduction of index options on emerging market volatility in the context of Malaysia. Company specific daily closing prices for 29 listed companies were examined to determine the conditional volatility shifts before and after the introduction of index options. Multiple window periods are examined to avoid year-end effects.The exponential generalized autoregressive conditional heteroskedasticity (EGARCH) (1.1) model is used to determine the conditional volatility shift before and after the introduction of index options in Malaysia. The findings of this study suggest that the introduction of index options reduced market volatility in the Malaysia equity market at the 0.01 level of statistical significance. Further, this study contributed to extant literature because it uses company-specific daily equity price data and no such previous study exists on the impact of index options for this important emerging market. The study will be useful for academics, researchers, domestic and foreign investors and policy-makers, among others.

Keywords: Emerging market; Index options; Conditional volatility; EGARCH model.
JEL Classification: G00, G10, G15

1. Introduction

There has long been concern about the trade of derivatives instruments and its impact on the underlying spot market. One of the main reasons for this concern is the expectation among investors that speculation about future markets may destabilize the spot market. Moreover, a number of financial crises (market crashes in 1987, 2001, and 2007–2008) and numerous empirical analyses (Becketti and Roberts, 1990; Chatrath *et al.*, 1995) have also received the repeated attention of policymakers.

Investors speculate on futures prices and trade on the derivatives market to determine the uneven prices of today's spot market by adding future growth expectations. Speculating the prices of futures markets is a risky endeavor; investors enable hedges to mitigate these risks (Antoniou and Holmes, 1995). However, low trading costs compared with spot markets (Antoniou and Holmes, 1995) and possible limited loss (when the loss of an option contract by a contract seller is limited by the option price) attract investors to trade in the futures markets. Additionally, investors are more involved in the futures market than in the spot market. The futures market allows the prices of the spot market to be adjusted, which also attracts investors. Concerns regarding trade in the futures market are linked to the volatility of the underlying spot prices.

Theoretically, the expectation of the futures markets is that the benefits of futures trading (in terms of lower transaction costs and other benefits) will reduce the spot market volatility. The theory of the introduction of derivatives trading is debatable based on empirical research, which suggests three potential outcomes: i) the introduction of derivatives increases spot market volatility (Conrad, 1989; Edwards, 1988a;1988b; Harris *et al.*, 1994; Hogan *et al.*, 1997; Stein, 1987); ii) the introduction of derivatives decreases spot market volatility (Black, 1975; Chang *et al.*, 1999; Cox, 1976; Danthine, 1978; Harris, 1989; Maberly *et al.*, 1989); or iii) the introduction of derivative instruments has no impact on spot market volatility (Becketti and Roberts, 1990; Chatrath *et al.*, 1995; Darrat and Rahman, 1995; Edwards, 1988a;1988b; Fortune, 1989; Galloway and Miller, 1997; Kamara *et al.*, 1992; Rahman, 2001; Schwert, 1990).

Market volatility is recognized as a risk in most asset pricing models, and variations in the volatility changes the expected returns of all assets. Many statistical models have proposed to determine the volatility of a market, including rolling variance estimates (Officer, 1973); autoregressive conditional heteroskedasticity (ARCH) models (Engle, 1982); the generalized autoregressive conditional heteroskedasticity (GARCH) model (Bollerslev, 1986); and nonparametric methods (Harvey, 2001; Pagan and Schwert, 1990). In practice, the parameters of these models

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propose different volatility estimates. Additionally, it is not possible to determine actual volatility, and economic theory does not provide any conclusive argument that can capture the true conditional volatility. Furthermore, the estimated volatility may not be close to the actual volatility (Harvey and Whaley, 1992) because the standard law of repeated expectation is applicable to the estimation of conditional volatility (Harvey and Whaley, 1992). Harvey and Whaley (1992) also suggest that the information used by investors in their valuation mechanisms is not linear and cannot easily be used to predict market movement.

Previous studies have mainly used GARCH (1.1) to capture volatility (Andersen and Bollerslev, 1997; Baillie and Bollerslev, 1990; Dixit *et al.*, 2010; Hogan *et al.*, 1997; Kyriacou and Sarno, 1999; Locke and Sayers, 1993; Tse, 1999). This study used the exponential generalized autoregressive conditional heteroskedasticity (EGARCH, 1.1) model of Nelson (1991) to capture the impact of information asymmetry. Heynen *et al.* (1994) tested GARCH and EGARCH and found that EGARCH provided superior descriptions of asset prices and implied volatility for the term structure of options. EGARCH has also been used to capture conditional volatility by Brandt and Jones (2006) on the S&P 500 index, by Bhar and Nikolova (2009) on BRCI equity; by Sabbaghi (2011) on equity indices, by Gahlot and Datta (2011) on future contracts, and by Elyasiani and Mansur (2013) on hedge funds.

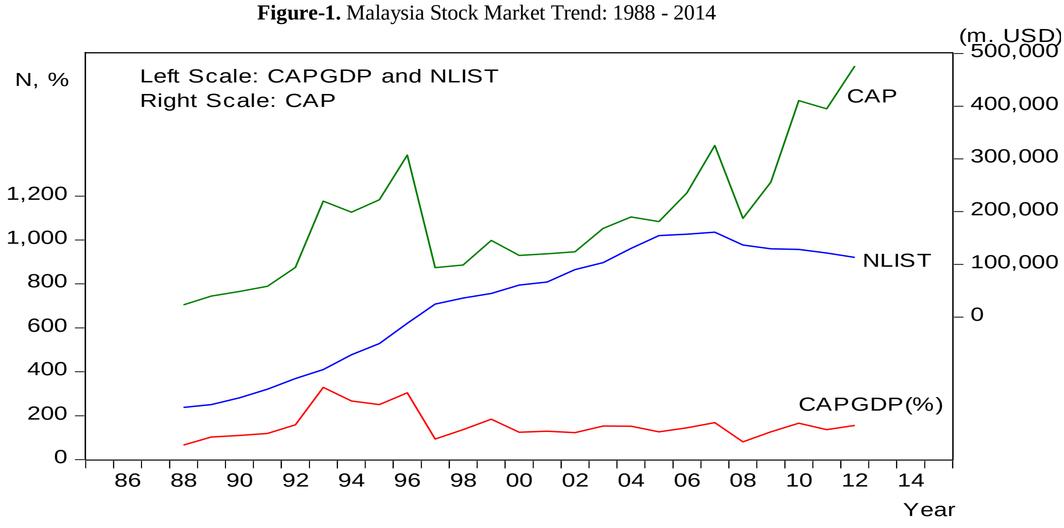
In a developed market, such as the United States, the prices of index options are reflected by the available information in the market and suggest that market participants cannot receive the benefits of information asymmetry Chang *et al.* (2010). However, the impact of information asymmetry in emerging markets has been found to be significant due to large capital flow by foreign investors (Froot *et al.*, 2001; Griffin *et al.*, 2004; Richards, 2005). This large capital flow generates pressure on prices for the entire market (Chang *et al.*, 2010). Moreover, the trading information of a foreign investor in an emerging market is comparatively less transparent or publicly available and has some degree of delay Chang *et al.* (2010). The findings of Chang *et al.* (2010) suggest the greater prevalence of information asymmetry in an emerging market, which motivated this study to investigate the Malaysian market, to which index options were introduced on July 6, 2009.

Previous studies on index options have typically investigated individual stock options and have suggested that the introduction of index options decreases volatility (Conrad (1989), on the USA; Elfakhani and Chaudhury (1995), on Canada; and Alkeback and Hagelin (1998) on Sweden). Another previous study found that market volatility depends on timing of the sample selection (Mayhew and Mihov, 2000). This study investigated a hypothesis regarding the impact of the introduction of index options, more specifically, FTSE Bursa Malaysia KLCI index options, on spot market volatility, which has not been studied previously.

Given the above review of relevant literature, this paper intends to empirically examine the impact of the introduction of derivatives trading on the unconditional and conditional volatility in an emerging equity market, the Malaysian equity market using daily equity price data. The study utilizes company-specific 29 listed company daily equity price data to examine and test such volatility effects. The study also explains the trends in volatility changes over a period of time by analyzing multiple window periods. These findings extend the findings of Mayhew and Mihov (2000) by analyzing data from an emerging market. Multiple periods were also observed to limit the findings of Edwin *et al.* (1988), who suggests that derivatives do not become an important mechanism immediately after their introduction. Furthermore, the observation of multiple periods also limits the year-end effect. The findings of this study are expected to contribute to the existing knowledge on spot market volatility in relation to derivatives trading in an emerging market. In addition, these findings will be useful for a regulatory body to determine future market efficiency in Malaysia. Policy makers might attempt to enact and implement new regulation if the trading of derivatives increases the spot market volatility significantly. However, policy-makers need to be cautious of the fact that additional regulations, if any, concerning derivatives trading might reduce the motivation of investors to trade in an emerging market, which might decrease future market efficiency. It is to be noted here that such a study has not been conducted for Malaysia before. The study uses the EGARCH (1,1) model to examine the conditional volatility as elaborated in the Methodology and Data section below.

The Malaysian Stock Exchange is one of the high growth emerging equity markets in Asia. As figure 1 demonstrates, market capitalization (CAP) increased quite rapidly (with some year-to-year fluctuations) since 1988 for which data could be obtained from the World Bank sources (World Bank, 2014). During the same period, the market capitalization as % of GDP stayed around 200% of GDP with some annual fluctuations around that rate. Similarly, the number of listed companies (NLIST) has increased rapidly from 1988 with some tapering off in recent years since around 2007-2008 perhaps due to the onset of the 2007-09 global recession emanating from the U.S. Further, as of May 31, 2014, the total market capital in Bursa Malaysia is USD 526,883.38 million (according to a statistic of the World Federation of Exchanges). Among the top 18 stock markets in Asia (in the context of market capitalization), the Malaysian Stock Exchange holds over 2.8% market capitals which grew over 15% in the last 10 years. This high growth rate of the market capitalization motivates this study to explain the impact of the index option in the context of Malaysia.

Figure-1. Malaysia Stock Market Trend: 1988 - 2014



2. Methodology and Data

This study employed the exponential GARCH (1.1) model that was introduced by Nelson (1991) to capture conditional volatility shift from pre to post-index options period. EGARCH (1.1) parameters are expressed in terms of the natural logarithm of the conditional variance.

The model is expressed as follows:

$$r_t = \sigma_t \varepsilon_t \quad (1)$$

$$\varepsilon_t \; Niid(0,1) \quad (2)$$

$$\ln \sigma_t^2 = \omega + \alpha_{\varepsilon_{t-1}} + \gamma \left[|\varepsilon_{t-1}| - \sqrt{\frac{2}{\pi}} \right] + \beta \ln\left(\sigma_{t-1}^2\right) \quad (3)$$

where $\omega, \alpha, \gamma, and \; \beta$ are constants and $\ln \sigma_t^2$ is known as a conditional variance if $\beta > 1, \varepsilon_t$ is stationary. α denotes the symmetric effect, β measures the persistence of conditional volatility, and γ denotes the leverage effect. In Equation (3), $\alpha_{\varepsilon_{t-1}}$ denotes the magnitude or cluster effect and $\gamma|\varepsilon_{t-1}|$ denotes the sign effect for the shock ε_t. If the value of α is positive, then large shocks will have greater impacts on volatility than small shocks. If $\gamma > 0$, then $\gamma\left[|\varepsilon_{t-1}| - \sqrt{\frac{2}{\pi}} \right]$ suggests that positive innovations are more destabilizing than negative innovations. If $\gamma = 0$, the process is symmetric $\gamma < 0$ suggests that good news leads to less conditional volatility than bad news.

Study used a dummy variable into the variance equation of the EGARCH (1.1) model. The combined EGARCH (1.1) model and dummy variable is defined as:

$$\ln \sigma_t^2 = \omega + d_1 D_1 + ... + d_n D_n + \alpha_{\varepsilon_{t-1}} + \gamma \left[|\varepsilon_{t-1}| - \sqrt{\frac{2}{\pi}} \right] + \beta \ln\left(\sigma_{t-1}^2\right) \quad (4)$$

where $D_1, ..., D_n$ are dummy variable taking on the value 0 in pre-index and 1 in post-index period. Dummy variable control other macro-economic factors and only explain the impact of index options on spot market volatility. The combined dummy variable also used by Aggarwal *et al.* (1999) and Rahman (2001) in volatility estimation.

Nelson (1991) provides three motivations for using the EGARCH (1.1) model that cannot be explained by the standard GARCH model of Bollerslev (1986): i) in asset price returns, the asymmetric behavior of the conditional variance cannot be explained by the GARCH model; ii) the parameters value should be positive for the conditional variance to be positive, which is not essential in the EGARCH model (Nelson and Cao (1992), found that non-negative constraints of the GARCH model were only true when conditional variance was positive); and iii) in the EGARCH model, the persistence of the conditional variance is controlled by β, which is difficult to measure in the GARCH model when the shock to variance persists. The natural logarithm of the conditional variance in the EGARCH (1.1) model is a function of $\varepsilon_{t-1}^2, \varepsilon_{t-1}$, and the natural logarithm of the conditional variance. The conditional variance depends on ε_{t-1} with the same magnitude, negative, and positive dissimilar impact on the conditional variance, which allows the EGARCH (1.1) model to capture the information asymmetry.

2.1. Data

An FTSE Bursa Malaysia KLCI index options was introduced on July 6, 2009. The study used the daily closing prices from the spot market before and after the introduction of index options. Theodore *et al.* (1992) used daily closing prices to estimate the conditional volatility by fitting the EGARCH model. Barone-Adesi *et al.* (2008) also used daily closing prices to estimate the conditional volatility. The sample period was divided into the three window periods shown in the table 1. We study multiple window periods to limit the year-end effect.

Table-1. Pre-Index and Post-Index Alternative Sample periods

Pre-index period	Post-index period	Window/Duration
April 6, 2009 to July 3, 2009	July 7, 2009 to October 6, 2009	1st (3 months)
January 6, 2009 to April 3, 2009	October 7, 2009 to January 6, 2010	2nd (3 months)
July 7, 2008 to January 5, 2009	January 7, 2010 to July 6, 2010	3rd (6 months)

Out of 30 stocks, the study observed 29 stocks for which trading data were available during the sample period. Data were collected from the Thomson *Reuters* DataStream. Contract specifications for the FTSE Bursa Malaysia KLCI index options were as follows:

Table-2. Contract specifications for the FTSE Bursa Malaysia KLCI index options

Exchange	Bursa Malaysia Derivatives (BMD)
Underlying instrument	FBM KLCI Futures (FKLI)
Type	European Style
Contract size	One FKLI contract
Tick size	0.1 index points valued at RM5
Contract months	The spot month, the next month, and the next 2 calendar quarterly months. The calendar quarterly months are March, June, September, and December
Trading hours	There are two trading sessions. The 1st session starts at 8:45 a.m. and ends at 12:45 p.m., and the 2nd session starts at 2:30 p.m. and ends at 5:15 p.m.
Last trading day	The last trading day of the contract month.
Exercise price interval	A minimum of thirteen exercise prices will be sent at intervals of 10 index points for the spot and following-month contracts; 6 will be in the money, 6 will be out of the money, and 1 will be at the money. A minimum of 7 exercise prices will be send at the interval of 20 index points for the next 2 quarterly month contracts; 3 will be in the money, 1 will be at the money and 3 will be out of the money.
Settlement of option exercise	Options that are in the money at the expiration date without any instruction will be automatically exercised. Exercise results for a call buyer or put seller in a long position or a put buyer and call seller in a short position will be cash settled based on the final settlement value.
Speculative position limit	The speculative position limit is 10,000 FKLI-equivalent contracts, which are a combination of OKLI and FKLI contracts.

Source: www.opf.com.my (last updated on December 1, 2013).

3. Empirical Analysis

This study computed the mean returns and return variances of each stock before and after the introduction of index options to capture the impact of index options on spot market volatility. The results are presented in the Table 1. The average returns for the entire sample before and after the introduction of index options were 0.019% and 1.85%, respectively, suggesting that the returns increase after the introduction of index options. The findings also suggest that the return variance of the entire sample declines after the introduction of index options (the average variances before and after the index options are 1.35% and 0.44%, respectively). This finding illustrates the applicability of EGARCH (1.1) for capturing the conditional volatility shift from before to after the introduction of index options.

This study examined the distributional properties of the daily returns before and after the event to justify fitting the EGARCH (1.1) model. The test results are presented in the Table 3 for one year after the introduction of index options. Most of the stocks returns were positively skewed, which suggests that the return series has a long right tail. The test results suggest that after the introduction of index options in Malaysia, investors could expect frequent small losses but few extreme losses. All the stocks exhibited positive excess kurtosis (>3) at the 0.01 significance level. Leptokurtic distribution refers to a fatter tail and suggests that there are fewer opportunities for extreme outcomes compared with a normal distribution. All the stocks had very small interquartile range (IQR) values, suggesting that the daily return series in the spot market after the introduction of index options was clustered around the mean. These findings also suggest that the return series followed the white noise process.

Table-3. Sample mean returns and return variances by Listed Companies before and after the introduction of index options

		Before		After	
ID	Name	Average	Variance	Average	Variance
1	AMMB HOLDINGS	0.000329	0.000544	0.001478	0.000133
2	AXIATA GROUP	-0.001884	0.000921	0.001799	0.000193
3	BERJAYA SPORTS TOTO	0.000109	0.000200	-0.000476	0.000114
4	BRIT.AMER.TOB.(MALAYSIA)	0.000245	0.000141	-0.000075	0.000090
5	CIMB GROUP HOLDINGS	0.000961	0.000593	0.001486	0.000147
6	DIGI.COM	-0.000254	0.000178	0.000194	0.000080
7	GAMUDA	0.000724	0.001066	0.000631	0.000277
8	GENTING MALAYSIA	0.000317	0.000544	-0.000087	0.000184
9	GENTING	0.000347	0.000676	0.000902	0.000280
10	HONG LEONG BANK	-0.000275	0.000206	0.001610	0.000114
11	HONG LEONG FINL.GP.	0.000494	0.000345	0.001915	0.000199
12	IOI	-0.001446	0.001190	0.000425	0.000119
13	KUALA LUMPUR KEPONG	-0.001326	0.000582	0.001202	0.000455
14	MISC BHD.	0.000231	0.000161	0.000164	0.000103
15	MMC	-0.000735	0.001209	0.000695	0.000311
16	MALAYAN BANKING	-0.000345	0.000650	0.001106	0.000101
17	MALAYSIAN AIRLINE SY.	-0.000125	0.000734	-0.000604	0.000476
18	PPB GROUP	0.000453	0.000301	0.001152	0.000152
19	PETRONAS DAGANGAN	0.000497	0.000206	0.000564	0.000122
20	PETRONAS GAS	-0.000039	0.000075	0.000055	0.000043
21	PLUS EXPRESSWAYS	0.000629	0.000186	0.000269	0.000061
22	PUBLIC BANK	-0.000380	0.000200	0.001034	0.000061
23	RHB CAP.	0.000057	0.000588	0.001270	0.000149
24	SIME DARBY	-0.000723	0.000594	0.000156	0.000082
25	TELEKOM MALAYSIA	0.000792	0.000345	0.000593	0.000081
26	TENAGA NASIONAL	-0.000025	0.000456	0.000338	0.000066
27	UMW HOLDINGS	0.000295	0.000225	0.000211	0.000057
28	YTL	0.000322	0.000267	0.000437	0.000108
29	YTL POWER INTERNATIONAL	0.000944	0.000128	0.000053	0.000047

Source: Author Calculations

The study used the Ljung-Box Ljung and Box (1978) portmanteau test, which is known as a white-noise test, to examine the independence of the data after the introduction of index options. To examine the independence, the study applied the Ljung-Box test up to 12 lags with M degrees of freedom, and lag (m) was asymptotically distributed as a chi-square. The test results are presented in Table 3. The critical value for most of the identification number(IDs) suggests that the data after the introduction of index options exhibit a striking white noise process. This finding suggests that the return series were independent after the introduction of index options.

Table-4. Sample skewness, kurtosis, minimum, maximum, and IQR by Listed Companies after the introduction of index options.

ID	Skewness	Kurtosis	Minimum	Maximum	IQR
1	-0.132	5.243	-0.042	0.044	0.012
2	1.111	7.475	-0.042	0.064	0.012
3	-1.517	13.927	-0.079	0.030	0.009
4	0.286	4.811	-0.026	0.040	0.008
5	0.193	5.487	-0.047	0.047	0.012
6	-0.071	11.234	-0.044	0.049	0.005
7	0.304	6.210	-0.065	0.074	0.014
8	0.249	5.461	-0.058	0.054	0.014
9	0.491	4.047	-0.046	0.062	0.019
10	-0.180	7.171	-0.053	0.043	0.008
11	0.031	5.997	-0.066	0.059	0.014
12	0.278	6.854	-0.051	0.045	0.008
13	-0.229	79.002	-0.216	0.213	0.007
14	0.057	6.524	-0.039	0.040	0.007
15	0.473	6.299	-0.059	0.076	0.012
16	0.943	7.695	-0.033	0.054	0.008
17	0.568	6.874	-0.075	0.114	0.022
18	0.067	8.788	-0.060	0.064	0.008
19	0.159	8.785	-0.057	0.050	0.008
20	-0.679	8.412	-0.040	0.020	0.004
21	0.015	8.217	-0.037	0.037	0.006
22	0.917	14.210	-0.037	0.053	0.004
23	0.364	5.974	-0.043	0.045	0.011
24	0.059	8.958	-0.047	0.039	0.007
25	-0.305	8.661	-0.047	0.036	0.007
26	1.689	13.200	-0.024	0.052	0.005
27	0.161	7.520	-0.028	0.040	0.005
28	-0.427	8.897	-0.058	0.048	0.007
29	-0.358	6.227	-0.036	0.018	0.009

The study also applied autocorrelation and partial autocorrelation to examine the randomness of the sample data. The study results are presented in Table 3 for up to 12 lags. The critical value for most of the lags suggests that the return series had no serial autocorrelation at the 0.05 significance level but did exhibit volatility clustering. The sample data exhibited a fat tail with a mean return of less than zero, suggesting the need for a higher-order GARCH model to examine the conditional volatility clustering. In this scenario, an EGARCH (1.1) process appeared to be appropriate for examining the conditional volatility shift.

Table-5. Sample returns' autocorrelation (AC), partial autocorrelation (PAC), and Ljung-Box test results by Listed Companies

	Lags	1	2	3	4	5	6	7	8	9	10	11	12
1	Ljung-Box	2.13%	6.56%	13.40%	23.21%	34.41%	42.92%	44.17%	54.85%	45.25%	24.29%	21.63%	25.36%
	AC	14.19%	-2.36%	-2.21%	-0.60%	1.23%	3.47%	6.11%	0.72%	-8.94%	-12.53%	-8.19%	-4.40%
	PAC	14.17%	-4.49%	-1.18%	-0.17%	1.19%	3.15%	5.34%	-0.31%	-8.26%	-9.89%	-5.87%	-3.70%
2	Ljung-Box	74.99%	2.37%	5.23%	9.52%	4.78%	7.15%	11.14%	15.76%	21.78%	28.81%	36.28%	43.29%
	AC	1.96%	16.95%	-2.98%	-2.69%	-11.27%	4.14%	1.90%	2.80%	1.68%	1.32%	-1.54%	2.66%
	PAC	1.96%	16.67%	-3.79%	-5.54%	-10.20%	6.91%	6.07%	1.28%	-1.24%	0.53%	-0.88%	3.51%
3	Ljung-Box	0.17%	0.70%	1.83%	3.72%	6.79%	10.56%	13.26%	12.85%	18.02%	21.88%	27.67%	28.73%
	AC	-19.52%	1.71%	-2.09%	-2.58%	-1.96%	3.24%	5.66%	-8.67%	2.01%	-4.99%	2.96%	-7.26%
	PAC	-19.64%	-2.10%	-1.90%	-3.40%	-3.90%	1.47%	6.13%	-5.09%	-1.29%	-4.81%	0.92%	-6.54%
4	Ljung-Box	2.83%	4.76%	1.48%	2.95%	4.70%	4.22%	6.85%	3.09%	0.79%	0.74%	1.24%	0.51%
	AC	-13.54%	7.06%	13.08%	-3.15%	-4.30%	-8.40%	1.98%	-12.07%	-14.45%	-8.34%	-0.14%	-12.85%
	PAC	-13.56%	5.48%	15.14%	-0.03%	-7.02%	-12.10%	0.73%	-9.04%	-16.13%	-13.37%	1.23%	-9.00%
5	Ljung-Box	17.78%	39.83%	36.39%	33.07%	43.25%	51.86%	55.84%	65.55%	74.40%	72.01%	56.66%	60.97%
	AC	8.39%	-1.00%	7.22%	7.41%	-3.21%	-3.63%	5.06%	-1.84%	-1.13%	-6.64%	-10.15%	-4.40%

	PAC	8.30%	-1.63%	7.36%	6.22%	-4.17%	-3.49%	4.40%	-2.82%	-0.12%	-6.70%	-9.57%	-2.74%
6	Ljung-Box	0.00%	0.00%	0.00%	0.00%	0.01%	0.03%	0.04%	0.02%	0.04%	0.02%	0.04%	0.07%
	AC	-28.24%	-12.71%	1.49%	-2.12%	-0.96%	-3.09%	6.61%	-10.92%	-5.15%	11.29%	-3.48%	2.72%
	PAC	-28.36%	-22.34%	-10.71%	-8.67%	-6.24%	-8.16%	1.80%	-11.49%	-13.78%	0.17%	-4.39%	1.09%
7	Ljung-Box	34.65%	47.85%	66.95%	75.51%	85.88%	91.10%	94.51%	95.76%	93.71%	96.45%	97.79%	98.27%
	AC	5.79%	4.72%	-1.75%	-3.58%	1.15%	-2.49%	2.44%	-3.65%	6.28%	0.05%	2.24%	-3.88%
	PAC	5.79%	4.40%	-2.28%	-3.56%	1.76%	-2.40%	2.41%	-3.77%	6.38%	-0.31%	2.02%	-3.91%
8	Ljung-Box	5.90%	15.96%	8.56%	7.35%	12.66%	17.47%	21.79%	20.94%	20.20%	10.65%	10.93%	15.08%
	AC	-11.62%	1.99%	-10.74%	-8.72%	-1.33%	-3.92%	4.59%	7.37%	7.31%	-11.91%	-6.94%	0.88%
	PAC	-11.63%	0.65%	-10.76%	-11.76%	-4.06%	-6.29%	0.95%	6.81%	8.22%	-10.41%	-8.84%	1.33%
9	Ljung-Box	68.10%	88.04%	89.47%	77.52%	24.70%	35.27%	25.61%	34.14%	16.49%	21.91%	21.18%	18.02%
	AC	2.54%	1.82%	3.69%	-6.73%	-13.68%	0.46%	-9.45%	1.51%	12.42%	-2.31%	-7.25%	8.63%
	PAC	2.56%	1.75%	3.62%	-6.98%	-13.55%	1.17%	-8.73%	2.51%	11.17%	-3.76%	-8.79%	6.90%
10	Ljung-Box	8.13%	14.38%	20.74%	30.07%	43.16%	43.08%	35.19%	30.23%	39.23%	37.61%	46.12%	30.80%
	AC	10.84%	5.69%	-5.10%	3.48%	-0.13%	-6.35%	-8.39%	8.08%	0.54%	7.09%	-0.94%	11.23%
	PAC	10.73%	4.49%	-6.23%	4.44%	-0.38%	-7.19%	-6.44%	10.64%	-1.84%	6.03%	-0.97%	10.88%
11	Ljung-Box	82.34%	73.20%	82.90%	92.14%	85.73%	87.88%	65.49%	71.92%	76.00%	82.66%	86.56%	84.81%
	AC	1.38%	-4.70%	3.16%	1.19%	-6.27%	-4.28%	-10.21%	3.53%	4.19%	1.61%	3.15%	-6.43%
	PAC	1.38%	-4.76%	3.33%	0.85%	-6.06%	-4.04%	-10.59%	3.86%	3.27%	2.04%	3.03%	-8.40%
12	Ljung-Box	29.00%	57.13%	77.23%	69.64%	65.80%	65.08%	74.73%	24.31%	32.49%	37.26%	45.16%	33.08%
	AC	6.53%	-0.01%	-0.02%	-6.46%	6.35%	5.93%	-1.82%	-15.19%	-0.31%	-4.31%	-1.87%	10.28%
	PAC	6.55%	-0.43%	-0.01%	-6.48%	7.18%	5.08%	-2.42%	-15.54%	2.37%	-4.17%	-2.34%	8.65%
13	Ljung-Box	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	AC	-40.95%	2.75%	-5.19%	1.66%	-4.68%	8.49%	-6.75%	1.35%	-1.62%	-2.09%	3.42%	2.64%
	PAC	-40.93%	-16.88%	-13.44%	-7.26%	-9.71%	2.43%	-3.42%	-3.08%	-3.42%	-6.07%	-0.35%	3.51%
14	Ljung-Box	92.24%	6.99%	13.99%	21.12%	31.16%	42.04%	53.36%	60.14%	69.56%	76.36%	75.93%	82.38%
	AC	0.60%	-14.24%	-2.45%	3.72%	-1.98%	1.74%	1.05%	-3.70%	0.99%	-2.42%	-5.81%	0.62%
	PAC	0.61%	-14.30%	-2.33%	1.76%	-2.61%	2.63%	0.66%	-3.39%	1.55%	-3.76%	-5.80%	0.07%
15	Ljung-Box	9.19%	17.18%	29.60%	11.91%	8.69%	14.18%	20.42%	22.35%	30.17%	38.67%	30.68%	32.21%
	AC	-10.57%	5.17%	2.61%	-11.91%	9.41%	0.02%	-2.22%	-6.11%	-0.30%	0.11%	-9.65%	6.34%
	PAC	-10.70%	4.17%	3.69%	-11.75%	7.04%	3.03%	-2.40%	-8.70%	0.57%	0.24%	-9.98%	3.50%
16	Ljung-Box	9.73%	24.42%	40.00%	45.00%	59.46%	58.31%	63.16%	70.43%	50.73%	59.31%	67.99%	62.25%
	AC	10.21%	1.63%	2.20%	-5.39%	0.40%	-6.28%	-4.73%	-3.26%	10.93%	-2.03%	-0.28%	8.43%
	PAC	10.20%	0.58%	1.98%	-5.78%	1.43%	-6.18%	-2.86%	-2.53%	11.64%	-4.19%	0.14%	6.30%
17	Ljung-Box	62.88%	40.71%	21.94%	28.70%	31.19%	29.93%	29.56%	14.61%	19.98%	14.71%	9.00%	7.27%
	AC	-2.98%	-7.70%	-9.97%	4.70%	-6.00%	7.04%	6.77%	-11.94%	2.26%	-9.58%	-10.95%	-8.98%
	PAC	-2.98%	-7.79%	-10.53%	3.47%	-7.31%	6.32%	7.16%	-12.21%	4.45%	-11.29%	-13.97%	-9.36%
18	Ljung-Box	81.60%	8.07%	13.62%	0.63%	0.22%	0.45%	0.74%	1.30%	2.10%	3.29%	2.62%	3.21%
	AC	-1.43%	13.72%	4.37%	18.18%	12.90%	1.39%	-4.20%	2.14%	2.63%	-1.92%	-9.34%	5.58%
	PAC	-1.43%	13.70%	4.82%	16.74%	13.09%	-2.43%	-9.30%	-2.95%	-0.50%	-2.79%	-7.39%	7.29%
19	Ljung-Box	0.01%	0.01%	0.01%	0.04%	0.07%	0.14%	0.15%	0.10%	0.20%	0.28%	0.47%	0.13%

	AC	-25.26%	-11.53%	-6.45%	-2.35%	5.84%	-2.39%	8.44%	-10.61%	0.30%	-5.83%	3.11%	16.15%
	PAC	-25.81%	-19.15%	-16.20%	-12.46%	-1.48%	-4.46%	7.42%	-7.52%	-2.49%	-11.02%	-3.34%	14.89%
20	Ljung-Box	0.04%	0.19%	0.47%	1.02%	2.07%	0.01%	0.03%	0.06%	0.10%	0.14%	0.22%	0.19%
	ACF	-21.82%	1.61%	-4.15%	-3.18%	-1.55%	-22.76%	3.92%	-1.40%	-4.21%	5.20%	4.43%	8.67%
	PACF	-21.71%	-3.32%	-4.72%	-5.23%	-3.69%	-25.59%	-8.69%	-4.79%	-9.87%	-2.25%	1.43%	3.13%
21	Ljung-Box	0.24%	0.11%	0.26%	0.46%	0.57%	0.50%	0.20%	0.02%	0.03%	0.03%	0.05%	0.05%
	AC	-18.77%	-13.17%	4.73%	5.60%	-7.30%	-9.11%	12.51%	-16.81%	-7.44%	7.78%	3.99%	-8.71%
	PAC	-18.69%	-16.99%	-1.26%	4.45%	-4.80%	-11.05%	6.73%	-16.29%	-12.17%	-1.47%	1.64%	-6.09%
22	Ljung-Box	2.44%	0.64%	0.08%	0.18%	0.20%	0.39%	0.44%	0.83%	0.39%	0.67%	1.11%	1.78%
	AC	13.90%	13.82%	15.84%	3.96%	-8.27%	3.20%	-7.73%	-0.22%	12.38%	-2.11%	-1.63%	-1.07%
	PAC	13.86%	12.07%	12.84%	-1.00%	-12.47%	3.29%	-6.11%	3.76%	13.62%	-4.35%	-3.56%	-4.49%
23	Ljung-Box	90.22%	72.79%	13.41%	17.15%	26.85%	27.23%	19.21%	24.25%	31.92%	40.62%	12.88%	13.55%
	AC	0.76%	-4.84%	13.65%	-5.54%	-0.72%	-6.59%	-9.62%	-3.91%	-1.59%	-0.05%	-15.20%	6.41%
	PAC	0.76%	-4.85%	13.76%	-6.24%	0.86%	-9.33%	-7.61%	-5.09%	-0.36%	0.89%	-15.56%	6.20%
24	Ljung-Box	39.69%	17.23%	29.46%	44.24%	3.69%	2.42%	0.88%	1.59%	1.99%	2.36%	3.69%	3.24%
	AC	5.23%	10.50%	2.75%	1.10%	18.11%	10.44%	13.33%	-0.35%	-5.98%	-6.32%	-0.69%	9.20%
	PAC	5.24%	10.48%	1.88%	0.23%	18.57%	9.68%	10.39%	-2.77%	-8.25%	-10.52%	-3.73%	5.30%
25	Ljung-Box	3.10%	8.84%	16.59%	18.17%	7.50%	1.91%	2.53%	2.20%	3.61%	2.09%	2.87%	4.13%
	AC	13.28%	2.73%	-2.94%	-6.63%	-11.92%	-13.90%	-5.59%	-8.49%	-0.95%	10.80%	4.12%	-2.75%
	PAC	13.29%	0.98%	-3.48%	-5.89%	-10.36%	-11.29%	-2.67%	-8.51%	-1.09%	8.68%	-1.71%	-6.92%
26	Ljung-Box	94.01%	98.14%	77.87%	88.68%	42.88%	16.12%	23.61%	31.96%	4.81%	7.27%	10.23%	13.68%
	AC	-0.46%	-1.10%	-6.34%	-1.49%	-12.48%	13.43%	-0.61%	-1.26%	-18.32%	1.30%	-2.27%	2.90%
	PAC	-0.46%	-1.10%	-6.32%	-1.46%	-11.86%	12.66%	-1.22%	-2.46%	-16.55%	-1.28%	0.34%	-0.38%
27	Ljung-Box	26.96%	42.13%	19.61%	25.30%	7.83%	12.90%	18.34%	23.69%	12.20%	10.66%	12.74%	10.07%
	AC	-7.00%	4.56%	-10.97%	-5.21%	-13.62%	-0.47%	-2.86%	3.71%	12.43%	8.70%	-5.23%	-9.70%
	PAC	-6.90%	3.99%	-10.22%	-6.69%	-13.71%	-2.79%	-3.64%	0.05%	11.13%	8.90%	-3.18%	-8.13%
28	Ljung-Box	0.28%	1.08%	1.54%	0.57%	1.23%	1.04%	1.88%	2.66%	3.81%	5.91%	8.72%	6.47%
	AC	-18.48%	-2.06%	-7.26%	-12.64%	1.25%	-9.12%	1.68%	4.66%	3.98%	-0.43%	-0.28%	-9.61%
	PAC	-18.41%	-5.71%	-9.25%	-16.61%	-5.72%	-13.05%	-6.65%	-0.62%	1.76%	-2.48%	-1.29%	-10.95%
29	Ljung-Box	93.54%	87.17%	90.15%	95.84%	91.27%	53.57%	38.10%	36.64%	35.61%	27.40%	19.17%	25.20%
	AC	0.50%	3.19%	-3.38%	-1.54%	-5.70%	-11.62%	-9.62%	-6.90%	-6.79%	-9.23%	10.07%	-0.52%
	PAC	0.50%	3.18%	-3.42%	-1.60%	-5.50%	-11.72%	-9.52%	-7.07%	-7.98%	-11.45%	7.63%	-4.22%

Table-6. EGARCH (1.1) parameter values for the 1st window period

	30 days				**30 days**			
	ω	α_0	γ	β	ω	α_0	γ	β
1	-0.61068	0.4462	2.60672*	0.93608*	0.1539	0.2955	1.63662*	1.08395*
	(-0.22)	(0.75)	(12.68)	(15.02)	(0.01)	(0.32)	(5.42)	(11.69)
2	-0.7896	0.26236	2.2375*	0.90306*	-0.10619	0.58042*	2.02991*	1.01164*
	(-0.61)	(0.26)	(13.19)	(16.94)	(-0.01)	(2.13)	(17.53)	(35.52)
3	-1.85143	0.25245	1.50811*	0.77481*	0.17266	0.07019	0.89391*	1.04355*
	(-0.94)	(0.34)	(4.66)	(8.14)	(0.01)	(0.05)	(2.09)	(16.75)
4	-3.24491	-0.10353	2.38576*	0.59284	-2.08237	0.30649	0.6711*	0.77345*

	(-1.24)	(-0.19)	(2.47)	(1.70)	(-0.85)	(1.33)	(2.96)	(7.41)
5	-1.29954	0.26372	2.26776*	0.81675*	-2.9488*	0.19572	1.59299*	0.5257*
	(-1.22)	(0.32)	1`11(9.40)	(17.98)	(-2.62)	(0.08)	(2.38)	(2.93)
6	-0.74543	0.04869	1.32175	0.93475*	-2.21655	-0.20839	0.93539*	0.76193*
	(-0.11)	(0.01)	(3.68)	(13.25)	(-0.37)	(-0.32)	(2.49)	(3.12)
7	-1.08675	0.06475	1.66299*	0.85812*	-1.68586	0.6465*	2.40999*	0.72665*
	(-0.54)	(0.16)	(2.06)	(2.55)	(-1.73)	(2.59)	(30.50)	(11.52)
8	-2.20187	0.16813	2.22788*	0.63556*	-3.13658	0.33978	1.57666*	0.59154*
	(-1.83)	(0.23)	(2.14)	(2.79)	(-1.36)	(0.70)	(6.23)	(2.52)
9	-1.39534	0.12691	1.77697*	0.75486*	-1.55657	0.10574	2.05114*	0.75419*
	(-0.85)	(0.04)	(1.98)	(5.84)	(-0.63)	(0.03)	(4.00)	(4.06)
10	-3.49934*	-0.47233	1.15502*	0.58756*	-0.43911	0.11589	1.86408*	1.01018*
	(-5.14)	(-1.79)	(8.85)	(9.45)	(-0.09)	(0.03)	(4.44)	(17.93)
11	-4.00239	0.37068	0.5222	0.51237	2.7103*	0.17267	1.04902*	1.40398*
	(-1.83)	(1.36)	(0.78)	(1.78)	(2.77)	(1.11)	(3.73)	(39.50)
12	-1.25639	0.13195	2.15252*	0.85035*	0.42815	0.90021*	3.78735*	1.07671*
	(-0.27)	(0.07)	(4.82)	(5.40)	(0.55)	(2.13)	(7.2)	(8.7)
13	-1.71677	0.18426	2.01998*	0.77699*	-0.39837	-0.05479	2.57111*	0.99478*
	(-0.95)	(0.26)	(2.04)	(3.1)	(-0.2)	(-0.08)	(2.33)	(2.87)
14	-31.5934	-0.0116	-0.0449	-2.5584	-3.04075	0.29444	1.73765*	0.66577*
	(-0.70)	(-0.02)	(-0.06)	(0.36)	(-1.58)	(0.34)	(3.81)	(5.14)
15	-0.35584	0.13172	1.63574*	1.00248*	-0.71049	0.219	1.52216*	0.92183*
	(-0.09)	(0.11)	(6.31)	(23.25)	(-0.10)	(0.28)	(3.34)	(5.71)
16	-0.05307	0.11175	1.70837*	1.07579*	-0.63399	0.30426	1.945*	0.94388*
	(-0.00)	(0.05)	(3.79)	(6.52)	(-0.76)	(0.71)	(3.32)	(6.45)
17	-3.67544	-0.05658	1.0109*	0.48405	-5.0562*	0.51896*	0.71572	0.30492
	(-1.75)	(-0.04)	(5.72)	(1.45)	(-1.99)	(2.44)	(1.69)	(0.38)
18	-0.06971	-0.01046	1.80839*	1.05523*	-0.44889	0.30946	1.9117*	0.98677*
	(-0.01)	(-0.00)	(12.46)	(49.85)	(-0.6)	(0.67)	(3.34)	(6.4)
19	-0.59042	0.16066	1.4481*	0.95076*	2.47517*	0.70908*	1.87831*	1.3164*
	(-0.11)	(0.26)	(8.83)	(16.29)	(4.67)	(3.74)	(12.97)	(18.63)
20	-17.5975*	-0.04497	0.70284*	-0.9013*	-4.53235*	0.20188	0.89817*	0.50657*
	(-68.43)	(-0.05)	(5.02)	(-12.96)	(-4.30)	(0.25)	(3.75)	(4.05)
21	-1.98252	0.10734	1.21389*	0.7572*	-2.57245	-0.15205	1.12583	0.71794*
	(-0.71)	(0.04)	(2.14)	(6.81)	(-0.80)	(-0.21)	(1.62)	(4.43)
22	-1.02445	0.10615	1.96022*	0.9071*	-0.58031	0.33697	1.75584*	0.95324*
	(-0.82)	(0.32)	(4.01)	(5.24)	(-0.39)	(0.73)	(2.66)	(4.56)
23	-1.45364	0.1266	1.56866*	0.83616*	0.37479	0.17167	1.48759*	1.13649*
	(-1.21)	(0.11)	(6.80)	(19.36)	(0.14)	(0.22)	(12.26)	(49.03)
24	0.02294	0.77681	3.14031*	1.00878*	1.87115*	0.48169*	1.93403*	1.36543*
	(0.00)	(1.37)	(10.54)	(11.35)	(3.55)	(2.37)	(8.44)	(18.66)
25	-5.94278	-0.02476	1.23259	0.14538	-2.64499	0.09327	1.30421*	0.66456*
	(-0.73)	(-0.00)	(1.05)	(0.02)	(-0.84)	(0.08)	(3.71)	(2.92)
26	-1.6533	0.29034	1.70932*	0.75532*	-1.38205	0.12816	1.68421	0.86432*
	(-1.03)	(0.35)	(4.38)	(7.17)	(-0.51)	(0.21)	(1.46)	(2.5)

27	-2.62858	-0.03194	1.30358*	0.6491	-0.23044	0.23958	1.43162*	1.01288*
	(-0.34)	(-0.01)	(2.36)	(1.08)	(-0.01)	(0.52)	(5.68)	(7.51)
28	-1.53158	-0.26442	1.0284	0.81538*	-0.52099	0.12163	2.48983*	0.97252*
	(-0.27)	(-1.40)	(1.82)	(4.42)	(-0.08)	(0.05)	(8.04)	(17.33)
29	0.384258	0.296911	2.072631*	1.11199*	0.008668	-0.20442	1.103662*	1.016238*
	(0.07)	(0.27)	(8.39)	(31.31)	(0.00)	(-0.50)	(3.75)	(22.92)

*Statistically significant at the 0.05 level.

Since the introduction of the shock (introduction of the stock index options in Malaysia) and comparing the before-shock and after-shock parameter values (based on the average values of 29 stocks as reported in tables 5 and 6) of α (0.1175 and 0.2496), γ (1.6325 and 1.6549), and β (0.6216 and 0.9002) of the first windowsuggest that positive shocks (unexpected price increases) were more destabilizing than negative shocks in both periods. The positive value of α before and after the event also suggests that large surprises in spot market returns will lead to spot market volatility compared with smaller shocks and that higher (lower) volatility in the current period will lead to higher (lower) volatility in the subsequent periods. The statistically significant γ value also suggests that positive news increases volatility to a greater extent in the Malaysian spot market than negative news. The value of β indicates the current conditional volatility in the context of past conditional variance. The value of $\beta \prec 1$ in both periods met the stationary condition and suggested that the average volatility persistence before the index options were introduced was 62%, which increased to 90% after the index options were introduced. The values of α and γ on the relative scales suggest positive leverage effects in both periods. To further investigate the volatility clustering from before and after the introduction of index options, the study computed the EGARCH long-run average variances (Nelson, 1991) of both periods, which are expressed as follows:

$$In\sigma_t^2 = \frac{\omega + \eta \times \sum_{i=1}^{p} \alpha}{1 - \sum_{j=1}^{q} \beta} \qquad (5)$$

where $\omega, \alpha, and\ \beta$ are constants, $\ln \sigma_t^2$ is known as a conditional variance and $\eta = \sqrt{\frac{\pi}{2}}$.

The long-run average volatilities before and after the introduction of index options were 1.60% and 1.89%, respectively, which were not statistically significant (z-value of -1.01). This finding suggests no structural changes of conditional volatility in Malaysia due to the introduction of index options.

Table-7. EGARCH (1.1) parameter values for the 2nd window period

	60 days				**60 days**			
	ω	α_o	γ	β	ω	α_o	γ	β
1	-0.69905	-0.07481	1.70272*	0.94329*	-1.14797	0.00501	1.32541*	0.86751*
	(-0.09)	(-0.03)	(2.40)	(6.98)	(-0.29)	(0.00)	(3.60)	(7.45)
2	-0.49441	0.23419	2.76329*	0.95134*	-2.2473	0.28084	1.73511*	0.75909*
	(-0.14)	(0.18)	(11.28)	(7.85)	(-0.79)	(0.37)	(7.17)	(5.84)
3	-1.9403	0.3097	0.49343	0.78153*	0.85881	-0.05166	1.17423*	1.14367*
	(-0.18)	(0.72)	(0.93)	(2.04)	(0.19)	(-0.05)	(5.17)	(22.88)
4	-4.26413	0.46641	0.50135	0.51953	-1.16172	-0.07366	1.98614*	0.89619*
	(-0.92)	(1.58)	(0.50)	(1.01)	(-0.58)	(-0.02)	(6.63)	(19.57)
5	-3.72158*	0.12191	1.14546*	0.4051	2.73698*	-0.03904	0.81734*	1.39889*
	(-2.58)	(0.07)	(3.56)	(1.22)	(4.31)	(-0.03)	(4.39)	(64.34)
6	4.30908	0.03649	0.33152	1.47879	-1.25669	-0.23118	0.85546	0.87663*
	(0.20)	(0.10)	(0.32)	(1.89)	(-0.14)	(-0.58)	(1.90)	(5.30)
7	-5.65018*	0.3457	1.05473*	0.20551	2.78087*	1.09291*	6.61672*	1.53627*
	(-6.64)	(0.82)	(4.32)	(0.48)	(5.25)	(3.55)	(9.99)	(15.94)
8	-1.07286	-0.25547	1.30106*	0.90576*	-0.2713	0.03143	0.9553*	0.98171*
	(-1.89)	(-0.56)	(9.68)	(47.02)	(-0.01)	(0.03)	(2.25)	(9.32)

9	-2.72663*	-0.0397	2.09437*	0.55924*	-0.88297	0.18711	1.02581*	0.91677*
	(-3.00)	(-0.07)	(3.24)	(3.54)	(-0.11)	(0.42)	(2.63)	(6.87)
10	-5.20604	-0.28437	0.71657	0.33555	0.03584	0.70591	3.14657*	1.05288*
	(-0.30)	(-0.60)	(1.25)	(0.08)	(0.03)	(0.95)	(2.86)	(4.47)
11	0.18605	0.11304	0.94014*	1.04733*	0.2577	0.17068	1.54271*	1.11035*
	(0.00)	(0.21)	(3.18)	(7.06)	(0.02)	(0.16)	(4.11)	(13.84)
12	-2.25666	0.15064	1.05341*	0.69302*	-0.44801	-0.04906	1.20396*	0.97282*
	(-0.85)	(0.15)	(2.07)	(3.45)	(-0.04)	(-0.02)	(2.36)	(12.03)
13	-3.31865	0.04676	1.53159*	0.50207*	-0.27626	0.06012	1.12044*	0.99343*
	(-1.14)	(0.01)	(2.13)	(2.37)	(-0.01)	(0.02)	(3.24)	(7.71)
14	-1.44486	-0.10896	0.47916	0.82423	0.23041	-0.20736	1.06004*	1.04912*
	(-0.06)	(-0.15)	(0.71)	(1.28)	(0.01)	(-0.40)	(3.25)	(7.56)
15	-1.20043*	1.14797*	3.63416*	0.74466*	2.80405	0.0206	0.68002*	1.4172*
	(-2.73)	(4.84)	(66.92)	(29.16)	(1.49)	(0.02)	(7.01)	(19.86)
16	-1.54928*	0.03994	2.28827*	0.71928*	-6.84867	0.00569	1.51917*	0.24848
	(-4.25)	(0.00)	(5.17)	(19.23)	(-1.89)	(0.00)	(6.91)	(0.20)
17	-0.00546	-0.09721	1.24011*	1.05692*	-0.71276	-0.09697	1.43493*	0.93332*
	(-0.02)	(-0.06)	(4.11)	(26.33)	(-0.10)	(-0.06)	(2.88)	(8.26)
18	-2.9877	-0.04382	1.37009*	0.65848	0.92577	-0.00541	0.99815*	1.14898*
	(-0.49)	(-0.01)	(2.36)	(1.72)	(0.22)	(-0.00)	(10.37)	(23.69)
19	0.04008	0.15885	0.39653	1.02029*	2.16074	-0.32708	0.98289*	1.27741*
	(0.00)	(0.66)	(1.80)	(7.08)	(0.54)	(-0.92)	(3.74)	(11.71)
20	-7.26257*	0.07617	0.80201*	0.26993	-9.92283*	0.40546	0.61116*	-0.02525
	(-2.45)	(0.02)	(2.13)	(0.33)	(-2.55)	(1.16)	(2.04)	(-0.00)
21	-1.96141	0.08893	0.83339*	0.7729*	-5.75281	-0.25485	1.25926	0.37042
	(-0.93)	(0.05)	(4.32)	(8.96)	(-0.86)	(-0.20)	(0.83)	(0.30)
22	-0.44508	0.06004	2.33175*	0.9987*	-0.67823	0.22329	1.35652*	0.94355*
	(-0.16)	(0.02)	(13.63)	(21.99)	(-0.07)	(0.19)	(4.98)	(8.86)
23	-1.96323	-0.20559	1.63167	0.72098*	2.46437	0.05606	0.57584*	1.33522*
	(-0.92)	(-0.56)	(1.59)	(2.15)	(0.98)	(0.21)	(5.12)	(18.27)
24	-3.37183*	0.4063	1.20042*	0.56753*	-1.43443	0.00911	1.31841*	0.86793*
	(-3.19)	(1.21)	(3.48)	(5.06)	(-0.57)	(0.00)	(2.33)	(15.69)
25	-0.22082	0.02633	2.44712*	1.01752*	-0.55392	-0.01374	1.35382	0.96095*
	(-0.42)	(0.09)	(6.77)	(14.1)	(-0.13)	(-0.03)	(1.18)	(2.13)
26	-1.67147	0.03	1.29291*	0.7811*	-0.5666	-0.33272	1.45764*	0.97345*
	(-0.51)	(0.01)	(6.79)	(5.50)	(-0.51)	(-1.65)	(3.85)	(7.87)
27	-5.24309	-0.1433	1.25662*	0.38431	-22.3734*	0.08744	0.21226	-1.17267
	(-1.56)	(-0.11)	(4.13)	(0.59)	(-6.89)	(0.13)	(0.13)	(-1.91)
28	12.70536	-0.01641	0.05359	2.44497	0.02883	0.11381	0.75958*	1.02618*
	(0.26)	(-0.15)	(0.07)	(0.76)	(0.00)	(0.23)	(4.54)	(9.53)
29	-3.19729	-0.18053	0.955427*	0.634533	-1.91957	-0.02736	1.493431*	0.79865*
	(-0.52)	(-0.26)	(2.55)	(1.44)	(-0.29)	(-0.00)	(2.41)	(4.05)

*Statistically significant at the 0.05 level.

Table-8. EGARCH (1.1) parameter values for the 3rd window period

	90 days				90 days			
	ω	α_o	γ	β	ω	α_o	γ	β
1	-0.7587*	0.04603	2.33533*	0.89669*	-1.60233	-0.05159	1.59148*	0.82856*
	(-3.66)	(0.02)	(21.88)	(106.31)	(-1.29)	(-0.26)	(4.39)	(5.15)
2	-0.45379*	0.44568	3.07717*	0.92168*	-0.92485*	0.63626*	3.39501*	0.84908*
	(-2.63)	(0.83)	(34.27)	(172.59)	(-2.89)	(3.00)	(68.38)	(69.82)
3	-2.00487	0.00223	1.36345*	0.72651*	-2.5319*	0.01507	1.00273*	0.68158*
	(-1.40)	(0.00)	(5.49)	(8.93)	(-2.85)	(0.06)	(22.36)	(14.76)
4	-1.57937	0.09085	1.60072*	0.7991*	-0.49718	0.05976	0.82838*	0.95514*
	(-1.15)	(0.09)	(8.17)	(13.61)	(-0.04)	(0.11)	(5.88)	(9.77)
5	-1.36797*	-0.10274	1.81596*	0.73836*	-0.45681	0.11251	1.62805*	0.98136*
	(-3.60)	(-0.05)	(6.38)	(18.78)	(-0.28)	(0.16)	(11.14)	(57.50)
6	-0.94979	-0.07014	1.45392*	0.88168*	-4.33862*	-0.07223	1.03506*	0.48569*
	(-0.73)	(-0.04)	(11.18)	(20.77)	(-3.50)	(-0.07)	(6.01)	(3.14)
7	-0.65501	-0.38989	2.90434*	0.85541*	-1.15364	-0.07007	1.40459*	0.84427*
	(-1.18)	(-0.79)	(43.58)	(29.58)	(-0.77)	(-0.26)	(2.69)	(3.61)
8	-1.987*	-0.19342	1.66798*	0.68208*	-0.37029	-0.14032	1.09177*	0.97111*
	(-6.92)	(-0.36)	(9.31)	(26.68)	(-0.04)	(-0.76)	(18.09)	(13.91)
9	-1.15285*	-0.12532	1.73422*	0.77333*	-1.51796	0.00265	1.53494*	0.79092*
	(-3.23)	(-0.11)	(11.82)	(25.55)	(-1.64)	(0.00)	(8.70)	(17.59)
10	-1.22975	-0.20831	1.39738*	0.84568*	-0.47526	-0.06403	1.13033*	0.9776*
	(-1.11)	(-0.58)	(5.48)	(20.68)	(-0.13)	(-0.06)	(9.12)	(30.33)
11	-0.93344	0.00028	1.68328*	0.86236*	-0.6992	0.0575	1.74687*	0.94051*
	(-1.07)	(0.00)	(4.30)	(5.68)	(-0.26)	(0.02)	(7.74)	(18.90)
12	-0.81656	-0.06241	1.73122*	0.81403*	-0.67955	0.22577	3.09788*	0.95107*
	(-1.91)	(-0.02)	(2.67)	(20.65)	(-0.42)	(0.25)	(28.03)	(37.95)
13	-0.10408	-0.32254	2.27298*	1.08144*	-3.97017*	-0.21612	1.04201	0.52101
	(-0.03)	(-0.51)	(7.54)	(40.76)	(-2.95)	(-0.39)	(3.18)	(3.17)
14	-2.85194*	-0.05235	1.27686*	0.63777*	-1.81137	0.00626	1.39508*	0.76027*
	(-2.40)	(-0.04)	(4.90)	(7.10)	(-0.72)	(0.00)	(3.77)	(5.91)
15	-0.83488*	0.06519	2.1188*	0.85803*	-1.16068	-0.11447	0.58009*	0.86757*
	(-2.42)	(0.16)	(4.02)	(7.69)	(-0.30)	(-0.78)	(7.02)	(9.85)
16	-0.54465	0.35148	2.97373*	0.9101*	-1.88914*	0.02775	1.83071*	0.75586*
	(-1.12)	(0.57)	(24.89)	(67.46)	(-4.61)	(0.00)	(10.40)	(35.18)
17	-0.59826	-0.06619	2.40571*	0.94945*	-1.77919	-0.06638	1.60745*	0.73225*
	(-0.60)	(-0.02)	(10.65)	(33.47)	(-1.88)	(-0.04)	(8.97)	(10.85)
18	-1.37632*	0.03092	1.95996*	0.80133*	-2.64*	-0.00878	1.56809*	0.60409*
	(-3.13)	(0.1)	(5.61)	(3.96)	(-2.61)	(-0.00)	(4.54)	(5.48)
19	-1.1485*	0.16079	1.36003*	0.87726*	-2.05314*	0.08465	1.43688*	0.74688*
	(-3.04)	(0.36)	(13.73)	(72.98)	(-2.24)	(0.13)	(9.34)	(18.72)
20	-2.28283	0.05061	0.40465	0.75262	-3.67834	0.03341	0.82543*	0.62128*
	(-0.07)	(0.13)	(0.98)	(0.66)	(-0.79)	(0.03)	(1.97)	(2.05)
21	-2.76672*	0.29475	1.22468*	0.62026*	-1.90934	-0.27146	0.98183*	0.80017*
	(-3.61)	(0.91)	(8.26)	(8.17)	(-1.08)	(-1.54)	(8.74)	(13.53)
22	-0.75626	-0.06049	1.9714*	0.92104*	-0.18149	0.0934	1.3483*	1.01047*
	(-1.26)	(-0.13)	(2.90)	(8.47)	(-0.12)	(0.38)	(3.67)	(5.28)
23	-1.31851*	-0.16479	1.38307*	0.80679*	-0.37477	0.06833	1.89454*	0.99331*

	(-2.39)	(-0.5)	(2.78)	(6.96)	(-0.07)	(0.03)	(7.69)	(19.15)
24	-0.58892	-0.06666	1.50129*	0.93749*	-1.49783*	-0.06317	1.80489*	0.81551*
	(-1.66)	(-0.06)	(15.68)	(106.61)	(-2.76)	(-0.03)	(8.45)	(36.11)
25	0.50378	-0.06068	0.71818*	1.13383*	-0.63457	0.07058	1.86591*	0.95141*
	(0.30)	(-0.11)	(7.43)	(44.60)	(-0.13)	(0.05)	(8.89)	(13.01)
26	-0.12434	-0.19766	1.8754*	1.04966*	-0.19354	0.05355	1.36675*	0.99721*
	(-0.02)	(-0.26)	(9.02)	(26.19)	(-00.01)	(0.07)	(17.16)	(18.90)
27	-1.95371*	-0.1322	1.5027*	0.71248*	-2.36838	0.07697	1.03353*	0.74102*
	(-7.94)	(-0.17)	(20.80)	(35.41)	(-1.75)	(0.11)	(6.82)	(12.35)
28	-1.77221	0.05333	1.82759*	0.73488*	-2.84402*	-0.09106	1.19981*	0.70108*
	(-1.88)	(0.03)	(10.49)	(12.26)	(-3.02)	(-0.26)	(9.31)	(15.38)
29	-2.37976*	0.008974	2.164971*	0.660639*	-1.90896	0.113337	1.148907*	0.802569*
	(-7.46)	(0.00)	(31.91)	(30.81)	(-1.11)	(0.33)	(7.17)	(15.02)

*Statistically significant at the 0.05 level.

Similar to the findings of the 1st window, the EGARCH (1.1) coefficients for the 2nd window also suggest that positive innovations (average values of 29 stocks; α : 0.0830 and 0.0601; γ : 1.304925 and 1.3992; β : 0.7911 and 0.8847) contributed more volatility than negative innovations before and after the introduction of index options in Malaysia. The value of α again suggests that the higher volatility of the current period will affect the volatility in subsequent periods. The findings also suggest the presence of a leverage effect (γ is positive and statistically significant); thus, positive news will contribute to greater stock market volatility than will negative news. The test results suggest that the persistence of average volatility (β) before the introduction of index options was 79%, which increased to 88% after the index options were introduced (see the table 7). Compared with the long-run average, the conditional volatility (measured by the equation 5) was 2.49% before the index options were introduced and declined significantly (z-value of 8.62 at the 0.01 significance level) to 0.19% after the index options were introduced.

In the 3rd window period, the average α was negative (-0.02326) before the index options were introduced and positive after the index options were introduced (0.01752). These findings suggest that after the index options were introduced, greater volatility will be sustained and will contribute to greater volatility in subsequent periods, whereas the opposite trend occurs before the introduction of the index options. However, α was statistically insignificant in both periods, whereas the positive value of γ was statistically significant in both periods, suggesting that positive surprises increase spot market volatility in Malaysia. In line with the 1st and 2nd window periods, the values of β (0.8359 and 0.8165 before and after the introduction of index options, respectively) were positive and less than 1, which was statistically significant at the 0.05 level. The average long-run volatility (measured by the equation 5) was 2.44% before and 1.36% after the index options were introduced. This volatility change was statistically significant (z-value of 4.58) at the 0.01 level. Moreover, the findings from the 2nd and 3rd window periods suggest that the introduction of index options decreased the average spot market volatility in Malaysia.

This study extends the findings of previous studies (Conrad (1989), on the USA; Elfakhani and Chaudhury (1995), on Canada; and Alkeback and Hagelin (1998), on Sweden) by examining an emerging market and suggests that the introduction of index options decreases spot market volatility. By examining multiple window periods, this study limits the year-end effects. Additionally, this study contributes to the studies of Mayhew and Mihov (2000) and Edwin *et al.* (1988) and suggests that the immediate impact of derivatives trading might not have an impact on spot market volatility, which might changes over time. The possible reason might bethe market participant's expectations and the associated risks from future market trading which changes over time.

4. Diagnostic Checking

This study used multivariate model named as Ljung-Box portmanteau test (Ljung and Box, 1978) to check the suitability of the EGARCH (1.1) specification as discussed earlier. The Ljung-Box equation is defined as follows:

$$Q_M = n(n+2)\sum_{k=1}^{M}\frac{r_k^2}{n-k} \quad (6)$$

where M is the maximum number of lags, r_k^2 is the sample autocorrelation at lag k, and n is the number of non-missing values in the sample data. The hypothesis H_0 rejects the test result if $Q_M . > x_\alpha^2$, where x_α^2 denotes the 100(1-α)th percentile of a chi-squared distribution with m degrees of freedom. This study computed the test statistic for up to 12 lags and results are presented in the table 5. Findings suggest that the return series are independent in both periods (the results for pre-index options period will be provided on request). Ljung-Box portmanteau test was used for conditional heteroskedasticity modeling to analyze time series data by Rahman (2001), Chiang and Doong (2001) and Bauwens *et al.* (2006). To check the goodness of fit of the EGARCH (1.1) model to the data, study estimated log-likelihood function (LLF) in case of normal (Gaussian) probability density function which is simplified as follows:

$$InL(\mu,\sigma| \ Y_1,Y_2....Y_N) = -\frac{N}{2} In(2\times\pi) - N\times In\sigma - \sum_{i=1}^{N}\frac{(Y_i-\mu)^2}{2\times\sigma^2} \quad (7)$$

where μ is the normal distribution mean, σ is the standard deviation of the underlying distribution and N is the number of observed values in the sample. The value of LLF meet the criteria of maximum log-likelihood estimation (the results of LLF will be provided on request) and suggest that the EGARCH (1.1) model fitted very well to sample data sets. Study by Rahman (2001) used log-likelihood function to justify the suitability of a multivariate model. Study also computed Akaike-Information Criterion (AIC) for small data sets to check the goodness of fit of the EGARCH (1.1) model. The AIC model is defined as follows:

$$AICc \ = AIC + \frac{2k(k+1)}{N-k-1} = \frac{2\times N\times k}{N-k-1} - 2\times In(L) \quad (8)$$

where N is the sample size and k is the number of model parameters. The fittings of EGARCH (1.1) parameters to the sample data sets also meet the goodness of fit criteria based on AIC test (the results of AIC will be provided upon request).

5. Conclusion

Trading derivative instruments has been shown to potentially impact on spot market volatility, which can increase (Edwards, 1988a;1988b; Hogan *et al.*, 1997) or decrease (Black, 1975; Cox, 1976). In the case of emerging markets, the trading of derivative instruments has received considerable attention from investors, policymakers, and researchers because emerging markets exhibit greater volatility than mature markets. This study examined the impact of FTSE Bursa Malaysia KLCI index options on spot market volatility. The FTSE Bursa Malaysia was introduced at the beginning of July 2009 in the Kuala Lumpur Stock Exchange. This study employed EGARCH (1.1) to explain the conditional volatility shift in Malaysia. Various statistics were used to examine the fitting of the model. In addition to other statistical results, the AC and PAC findings illustrate the suitability of EGARCH (1.1) for the sample data. The study examined 29 listed company stock prices and multiple window periods to limit the year-end effects.

The study results suggest that the introduction of index options caused no immediate structural changes in Malaysia. However, over time, the introduction of index options shifted the volatility downward; this result was significant at the 0.01 level. The overall test results suggest that introducing derivatives trading decreased spot market volatility in Malaysia. Various diagnostic tests suggest that the model and its estimates are quite reliable.

This finding will be useful for policymakers and market participants. Market participants can consider this finding in their asset pricing models to determine their expected prices, and policymakers can use this finding as a reference when developing new regulations concerning derivatives trading. Policymakers need to be cautious in introducing new regulations which may decrease the interest of market participants in trading in an emerging market, which could create market imperfections. However, targeted reasonable and prudent regulations might be helpful in curbing excessive greed and speculation and market manipulation that are characteristic of many emerging equity markets including Malaysia.

References

Aggarwal, R., Inclan, C. and Leal, R. (1999). Volatility in emerging stock markets. *Journal of Financial and Quantitative Analysis*, 34(1): 33-55.

Alkeback, P. and Hagelin, N. (1998). The impact of warrant introductions on the underlying stocks, with a comparison to stock options. *Journal of Futures Markets*, 18(3): 307–28.

Andersen, T. and Bollerslev, T. (1997). Intra-day periodicity and volatility persistence in financial markets. *Journal of Empirical Finance*, 4(2-3): 115–58.

Antoniou, A. and Holmes, P. (1995). Futures trading, information and spot price volatility: Evidence for the FTSE-100 stock index futures contract using GARCH. *Journal of Banking and Finance*, 19(1): 117–29.

Baillie, R. and Bollerslev, T. (1990). Intra-day and inter-market volatility in foreign exchange rates. *Review of Economic Studies*, 58(3): 565–85.

Barone-Adesi, G., Engle, R. F. and Mancini, L. (2008). A GARCH option pricing model with Filtered Historical Simulation. *The Review of Financial Studies*, 21: 1223-58. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=603382

Bauwens, L., Laurent, S. and Rombouts, J. (2006). Multivariate garch models: A survey. *Journal of Applied Econometrics*, 21(1): 79–109.

Becketti, S. and Roberts, D. (1990). Will increased regulation of stock futures reduce stock market volatility? Fderal Reserve Bank of Kansas City. *Economic Review*, 75(6): 33-46.

Bhar, R. and Nikolova, B. (2009). Return, volatility spillovers and dynamic correlation in the BRICequity markets: An analysis using a bivariate EGARCH framework. *Global Finance Journal*, 19(3): 203-18.
Black, F. (1975). Fact and fantasy in the use of options. *Financial Analysts Journal*, 31(4): 36–72.
Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, 31(3): 307–27.
Brandt, M. and Jones, C. (2006). Volatility forecastingwith range-based egarch models. *Journal of Business and Economic Statistics*, 24(4): 470–86.
Chang, Cheng, J. and Pinegar, M. (1999). Does futures trading increase stock market volatility? The case of the Nikkei stock index futures markets. *Journal of Banking and Finance*, 23(5): 727–53.
Chang, Hsieh, P. and Wang, Y. (2010). Information content of options trading volume for future volatility: Evidence from the Taiwan options market. *Journal of Banking & Finance*, 34(1): 174–83.
Chatrath, A., Ramchander, S. and Song, F. (1995). Does options trading lead to greater cash market volatility? *Journal of Futures Markets*, 15(7): 785–803.
Chiang, T. C. and Doong, S. (2001). Empirical analysis of stock returns and volatility: Evidence from seven asian stock markets based on tar-garch model. *Review of Quantitative Finance and Accounting*, 17(3): 301–18.
Conrad, J. (1989). The price effect of option introduction. *Journal of Finance*, 44(2): 487–98.
Cox, C. C. (1976). Futures trading and market information. *Journal of Political Economy*, 84(6): 1215–37.
Danthine, J. P. (1978). Information, futures prices and stabilizing speculation. *Journal of Economic Theory*, 17(1): 79–98.
Darrat, A. F. and Rahman, S. (1995). Has futures trading activity causes stock price volatility? *Journal of Futures Markets*, 15(5): 537–57.
Dixit, A., Yadav, S. and Jain, P. K. (2010). Informational efficiency of implied volatilities of S&P CNX Nifty index options A study in Indian securities market. *Journal of Advances in Management Research*, 7(1): 32-57.
Edwards, F. (1988a). Does the futures trade increase stock market volatility? *Financial Analysts Journal*, 44(1): 63–69.
Edwards, F. (1988b). Futures trading and cash market volatility: Stock index and interest rate futures. *Journal of Futures Markets*, 8(4): 421–39.
Edwin, D. M., David, S. A. and Roy, F. G. (1988). Stock index futures and cash market volatility. *Financial Analysts Journal*, 45(6): 75-77.
Elfakhani, S. and Chaudhury, M. (1995). The volatility effect of option listing: Some Canadian evidence. *Quarterly Review of Economics and Finance*, 35(1): 97–116.
Elyasiani, E. and Mansur, I. (2013). Hedge Fund Return and Volatility Patterns: A Higher-Moment Factor-EGARCH Model, Working paper.
Engle, R. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom Inflation. *Econometrica*, 50(4): 987-1007.
Fortune, P. (1989). An assessment of financial market volatility: Bills, bonds, and stocks. Federal reserve bank of boston. *New England Economic Review*: 13–28. Available: http://www.wbaonline.co.uk/abstract.asp?id=10251
Froot, K. A. O., O, C., P.G.J. and Seasholes, M. S. (2001). The portfolio flows of international investors. *Journal of Financial Economics*, 59(2): 151–94.
Gahlot, R. and Datta, S. (2011). Impact of future trading on efficiency and volatility of the indian stock market: A case of cnx 100. *Journal of Transnational Management*, 16(1): 43-57.
Galloway, T. and Miller, M. (1997). Index futures trading and stock return volatility: Evidence from the introduction of MidCap 400 index futures. *Financial Review*, 32(4): 845–66.
Griffin, J. M., Nardari, F. and Stulz, R. M. (2004). Are daily cross-border equity flows pushed or pulled? *Review of Economics and Statistics*, 86(3): 641–57.
Harris, L. (1989). S&P 500 cash stock price volatilities. *Journal of Finance*, 44(5): 1155–75.
Harris, L., Sofianos, G. and Shapiro, J. (1994). Program trading and intraday volatility. *Review of Financial Studies*, 7(4): 653–85.
Harvey, C. R. (2001). The specification of conditional expectations. *Journal of Empirical Finance*, 8(1): 573-637.
Harvey, C. R. and Whaley, R. (1992). Market volatility prediction and the efficiency of the S & P 100 index option market. *Journal of Financial Economics*, 31(1): 43-74.
Heynen, R., Kemna, A. and Vorst, T. (1994). Analysis of the term structure of implied volatilities. *Journal of Financial and Quantitative Analysis*, 29(1): 31-56.
Hogan, K., Kroner, K. and Sultan, J. (1997). Program trading, nonprogram trading, and market volatility. *Journal of Futures Markets*, 17(7): 733–56.
Kamara, A., Miller, T. and Siegel, A. (1992). The effects of futures trading on the stability of Standard and Poor 500 returns. *Journal of Futures Markets*, 12(6): 645–58.
Kyriacou, K. and Sarno, L. (1999). The temporal relationship between derivatives trading and spot market volatility in the uk: An empirical analysis and monte carlo evidance. *Journal of Futures Markets*, 19(3): 245–70.
Ljung and Box, G. (1978). On a measure of lack of fit in time series models. *Biometrika*, 65(2): 297–303.
Locke, P. and Sayers, C. (1993). Intra-day futures price volatility: Information effects and variance persistence. *Journal of Applied Econometrics*, 8(1): 15–30.

Maberly, E., Allen, D. and Gilbert, R. (1989). Stock index futures and cash market volatility. *Financial Analysts Journal*, 45(6): 75–77.

Mayhew, S. and Mihov, V. (2000). Another look at option listing effects. Working Paper.

Nelson, D. (1991). Conditional heteroskedasticity in asset returns: a new approach. *Econometrica*, 59(2): 347–70.

Nelson, D. and Cao, C. (1992). Inequality constraints in the univariate garch model. *Journal of Business & Economic Statistics*, 10(2): 229-35.

Officer, R. R. (1973). The Variability of the market factor of the NYSE. *Journal of Business*, 46(3): 434-53.

Pagan, A. R. and Schwert, G. W. (1990). Alternative models for conditional stock volatility. *Journal of Econometrics*, 45(1-2): 267-90.

Rahman, S. (2001). The introduction of derivatives on the Dow Jones industrial average and their impact on the volatility of component stocks. *The Journal of Futures Markets*, 21(7): 633–53.

Richards, A. (2005). Big fish in small ponds: The trading behavior and price impact of foreign investors in Asian emerging equity markets. *Journal of Financial and Quantitative Analysis*, 40(1): 1–27.

Sabbaghi, O. (2011). Asymmetric volatility and trading volume: The G5 evidence. *Journal of International Financial Markets, Institutions & Money*, 22(2): 169-81.

Schwert, G. (1990). Stock market volatility. *Financial Analysts Journal*, 46: 23–34. Available: http://schwert.ssb.rochester.edu/faj.htm

Stein, J. C. (1987). Informational externalities and welfare-reducing speculation. *Journal of Political Economy*, 95(6): 1123–45.

Theodore, E., Day, Lewis and Craig, M. (1992). Stock Market Volatility and the information content of stock index options. *Journal of Econometrics*, 52(1-2): 267-87.

Tse, Y. (1999). Price discovery and volatility spillovers in the DJIA index and futures markets. *Journal of Futures Markets*, 19(8): 911–30.